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United States
Environmental Protection
Agency

Environmental Monitoring Systems
Laboratory
Las Vegas NV 89114

Research and Development

EPA-600/S4-81-028 Aug. 1981

EPA

Project Summary

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Sampling and Analysis of Wastes Generated by Gray Iron Foundries

W. F. Beckert, T. A. Hinners, L. R. Williams, E. P. Meier, and T. E. Gran

This study was undertaken to determine how often the wastes generated by a representative number of gray iron foundries were identified as hazardous when tested according to procedures published in the Federal Register (Fed. Reg. Vol. 45, No. 98, 33066 pp; May 19, 1980).

Thirty (30) wastes generated by 21 gray iron foundries in Pennsylvania and Michigan were sampled and analyzed for selected inorganic constituents. The samples were collected in accordance with chain-of-custody procedures and sent to the Environmental Monitoring Systems Laboratory, Las Vegas (EMSL-LV). Three aliquots of each sample were extracted in accordance with the EPA Extraction Procedure (EP) (Fed. Reg. Vol. 45, No. 98, 33127-33128; May 19, 1980). A second set of three aliquots of each sample was digested with nitric acid/hydrogen peroxide. Both the extracts and the digests were analyzed for cadmium, chromium and lead by atomic absorption spectrophotometry and for 16 elements by inductively coupled plasma emission spectroscopy.

At the request of the American Foundrymen Society, aliquots of all raw samples, as well as splits of nine extracts and nine digests, were sent to Dr. W. Boyle, University of Wisconsin, for independent analysis. In addition, aliquots of each of 12 waste samples and splits of 9 extracts and 9 digests were analyzed by LFE Environmental Analysis Laboratories (now EAL Corporation), an analytical laboratory under contract to EMSL-LV. Excellent agreement was obtained between EMSL-LV and the other two laboratories.

Of the 30 samples evaluated for EP toxicity, a total of 9 (30 percent) exceeded the criteria levels for cadmium and/or lead. None of the extracts exceeded the hazardous waste criteria levels for chromium, arsenic, or barium. Extractable cadmium (using the EP) for the foundry wastes varied from 2.7 percent to 59.2 percent and extractable lead from 0.4 percent to 15.5 percent.

This Project Summary was developed by EPA's Environmental Monitoring Systems Laboratory, Las Vegas, NV, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Approximately 1,200 gray iron foundries and 81 ductile iron foundries are located throughout the United States, with many of the plants concentrated in the Great Lakes area. Similar types of melting equipment are used to produce both gray and ductile iron, and since the temperature and general metallurgical requirements are also similar for both processes, single foundries can produce both types of

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iron. More than 16 million tons of iron were produced in 1979 by this industry; an estimated 10 to 22 pounds of emission control dust is generated for every ton of iron produced.

The types of melting furnaces used for the production of gray iron and ductile iron are cupola, electric arc, and electric induction furnaces. It is estimated that approximately 95 percent of the furnaces used for producing gray iron and ductile iron are cupola furnaces. The emission control systems used are Venturi scrubbers and baghouses. Since the same types of raw materials are used to produce each type of iron, waste composition is expected to be similar.

In 1980, after evaluating the information available, the Environmental Protection Agency tentatively determined that the emission control dusts were hazardous wastes within the meaning of the Resource Conservation and Recovery Act (RCRA). The Agency thus proposed (Fed. Reg. Vol. 45, No. 138, 47836 pp; July 18, 1980) to list such material as a hazardous waste because:

1. Waste extracts from gray and ductile iron foundry emission control dusts have been shown to contain high concentrations of the heavy metals, lead and cadmium. In many cases the concentrations exceeded 100 times the drinking water standards for lead and cadmium, and in some cases exceeded 1,000 times the standard.
2. Large quantities of these wastes are generated annually, increasing the quantity of lead and cadmium available for environmental release.
3. These wastes may be disposed of in wetland or other areas where waste materials can become saturated with surface water or shallow groundwater, thus increasing the hazardous constituents' migratory potential.

In response to the comments received and in acknowledgement of the economic impact of such a listing, the EPA initiated a study to gather additional information on gray iron foundry emission control residuals in order to determine if, in fact, the waste should not be listed. On January 16, 1981, the Agency deferred final action on listing these wastes pending the outcome of this study (Fed. Reg. 46, No. 11, 4616 pp; January 16, 1981).

The objective of this study was to determine how often the wastes generated by a representative number of gray iron foundries would be identified as hazardous by the EPA Extraction Procedure. The parameters of primary interest were cadmium, chromium, and lead with EP extract criteria levels of 1, 5, and 5 mg/l, respectively, for identification of a waste as hazardous. A secondary objective was to determine the total concentration of these elements in the wastes studied. Chain-of-custody procedures were followed throughout this study.

Approach

Selection of Sampling Sites

The goal of the selection process was to provide a representative cross section of the types of foundries of interest and to minimize the logistical problems and expense associated with sample acquisition. For practical reasons, the sampling was limited to foundries located in Pennsylvania and Michigan. The selection of the foundries to be sampled and the notification of the companies were carried out by the Office of Solid Waste (OSW).

Factors considered in selecting the sampling sites included the nature of the charge used, furnace type, and scrubber type. A telephone survey of all gray iron foundries located in Pennsylvania and Michigan was conducted to obtain data on these factors from foundry representatives. It was pointed out by those representatives that the charge compositions they reported were characteristic of the individual foundries. Their information was accepted as quoted and formed the basis for the sampling and analytical program. A questionnaire in which a detailed description of the charge was requested was subsequently distributed to all the foundries that were to be sampled.

The foundries included in this study were selected on the basis of the factors listed above, on the clarity of response to the charge questions, and on the geographic location. The latter point was important because of the limited resources available for sampling. Therefore, the foundries chosen generally cluster around towns near airports in order to allow the sampling crew to fly in, rent a truck, and perform the sampling with a minimum of expense. However, in no case was quality sacrificed for budget.

Sample Collection and Sample Splitting

Since the exact nature of the waste storage and disposal facilities at each site was unknown, the sampling team leader used his best judgement to obtain a representative sample (or samples) of each waste of interest. Solid samples were taken with a trowel or scoop from the most recently (preferably same day) defined waste in a representative pattern throughout the area to be sampled and transferred to plastic containers. Most wet scrubber waste was sampled from holding tanks or hoppers; as much water as possible was decanted or squeezed from the plastic containers after sample collections. Guidelines presented in "Samplers and Sampling Procedures for Hazardous Waste Streams" (EPA-600/2-80-081, January 1980) were followed when it was appropriate and practical to do so. When requested, the foundries received split samples of the wastes collected from their facilities for this study.

During the Pennsylvania sampling trip, 13 scrubber-waste samples were collected from nine foundries. One of the furnaces sampled was an electric arc furnace; the others were cupola furnaces. During the Michigan sampling trip, 17 scrubber-waste samples were collected from 12 foundries. Two of the furnaces sampled were of the electric arc type; the others were cupola furnaces.

The waste samples received at the EMSL-LV were divided into aliquots of at least 450 g each. The samples were randomly distributed either for in-house analysis, to the University of Wisconsin, to LFE Environmental Analysis Laboratories, (now EAL Corporation) which was under contract to the EMSL-LV, or added to the secured EMSL-LV sample bank.

Sample Preparation

Aliquots of the raw foundry-waste samples were split into 100-g portions and extracted in triplicate by contractor personnel at the EMSL-LV laboratory facility. The NBS tumbling-type extractor was used throughout the study. The official Extraction Procedure (EP) was followed as specified in the Federal Register (Fed. Reg. Vol. 45, No. 98, 33127-33128; May 19, 1980) and explained in detail in Section 7 of "Test Methods for Evaluating Solid Waste," Office of Water and Waste Manage-

ment, SW-846. The extracts were then digested (as outlined in Section 8 of the above manual) and analyzed for the metals of interest.

Triplicate aliquots of the raw samples were digested using nitric acid/hydrogen peroxide and analyzed for the metals of interest.

Aliquots of 10 extracts and 9 digests prepared at the EMSL-LV were shipped to the University of Wisconsin and to LFE for analysis. This included a blind simulated extract containing 16.0 ppm each of Pb, Cd, and Cr in 0.7 percent nitric acid.

Sample Analysis

All extracts and digests were screened using ICP spectroscopy for the following 16 elements: Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Ni, Pb, V, and Zn. The instrument used for these screening analyses was an Applied Research Laboratories Inductively Coupled Plasma-Optical Emission Spectrometer (ICP-OES) with a 27.12 MHz radio frequency generator operated at 1.6 kw. Single-pass analyses were conducted where one pass consisted of calibration plus measurements on each solution. A Digital Equipment Corporation PDP 11/10 mini-computer was used for data handling and control of the ICP-OES during analysis.

All extracts and digests were analyzed for lead, cadmium, and chromium (and in some cases other elements) with an automated Perkin-Elmer Model 603 atomic absorption spectrophotometer (AAS). The procedures used are detailed in Section 8 of "Test Methods for Evaluating Solid Waste," EPA, Office of Water and Waste Management, SW-846. The AAS was equipped with a micro-processor and an automatic sample introduction system. It was interfaced with a PDP-11 computer for conventional flame analysis of fluids suitable for aspiration; it was also equipped with a deuterium background corrector to compensate for non-analyte absorption. Whenever the results of the AAS screening analysis of an extract indicated that the amount of cadmium, chromium or lead in the extract exceeded the criteria levels of 1, 5 and 5 mg/l, respectively, another aliquot of the same raw sample was extracted, the extract digested and the digested extract analyzed for confirmation using the background corrector and the method of standard addition.

Quality Assurance

The splitting of samples, extracts, and digests was performed by an independent in-house quality assurance team that was not otherwise involved in the study. All samples, including all duplicates, were therefore "blind" to the sample preparation team, the analytical team and to LFE, the reference laboratory. Twelve raw waste samples, including three blind splits, were sent to LFE for extraction, digestion, and analysis. Eight of the 36 solid waste samples extracted, digested, and analyzed at EMSL-LV were blind splits. All extractions and digestions were performed in triplicate. As part of the AAS analytical procedure, a standard was routinely analyzed every 10 samples. Filtration blanks were run to assure that the filtration equipment had been properly cleaned. Extracts, digests and reagent blanks were analyzed with a single-pass procedure for ICP measurements and with a double-pass procedure for AA measurements. One analysis pass consisted of calibration plus measurement on each solution.

Whenever the AAS screening analysis of an extract produced values for cadmium and/or lead that were above the criteria levels, another aliquot of the same raw waste sample was extracted and analyzed for confirmation by the method of standard addition (see Results and Discussion).

Results and Discussion

All extracts and digests were analyzed for cadmium, chromium, and lead using AAS without the method of addition. Since ICP spectroscopy showed that neither the barium nor the arsenic concentrations in the extracts exceeded 50 percent of the criteria levels (100 and 5 mg/l, respectively), even without background correction, no attempt was made to analyze for these two elements using AAS.

The results for the extracts and digests are listed in Table 1. The extracts from six field samples exceeded the critical concentration for cadmium of 1 mg/l, and the extracts from seven field samples exceeded the 5 mg/l limit for lead. None of the extracts exceeded the limit for chromium.

The analytical results for the aliquots of the raw waste samples sent to the University of Wisconsin (36 samples) and LFE (12 samples) agreed with the EMSL-LV results. The same wastes were identified as hazardous by all three laboratories.

In Table 1, extract data are reported as mg/l, the units used in the hazardous waste criteria level for toxicity specified in the Federal Register (Fed. Reg. Vol. 45, No. 98, 33127; May 19, 1980) for the Extraction Procedure. Digest data are reported as mg/kg of dry sample material to allow convenient estimates for the mass of an element contained in a given load of the solid waste. The concentrations of cadmium, chromium, and lead in the digests were often three orders of magnitude higher than those in corresponding EP extracts. However, the concentrations in the extract and digest solutions are not directly comparable because the ratio of final liquid volume to solid weight is 20/1 or more for the extracts and 100/1 for the digests. Furthermore, an EP extract is, according to the definition in the Federal Register quoted above, either the undiluted filtered liquid portion of a waste containing less than 0.5 percent of filtrable solids (examples in this study are samples #50 and #51), or the actual EP extract combined with any liquid was separated from the sample by filtration before the extraction step. The digestion, however, was always performed on the total solids of the dried samples.

To allow for an easier comparison, the amounts of cadmium, chromium and lead extracted from the samples using the EP are listed in Table 2 as percentages of the amounts found in the digests.

In order to confirm the AAS results, fresh aliquots of the wastes that had high concentrations of lead or cadmium in their EP extracts were extracted using the EPA Extraction Procedure, the extracts were digested, and the digests analyzed for cadmium, chromium, and lead using the method of standard addition. The results are listed in Table 3. All lead and cadmium values except one were confirmed to exceed the criteria levels.

The results are listed in Table 3. All lead and cadmium values except one were confirmed to exceed the criteria levels.

The occasionally large differences between the screening and the confirmatory AAS values are due to the variations in composition between aliquots of the same field samples. This variation is not surprising since many of these wastes were heterogeneous and difficult to mix. Mixing techniques that change the particle sizes (e.g., grinding

Table 1. *Summary of Atomic Absorption Screening Analyses of Waste EP Extracts and Waste Digests**

Foundry Code	Field Sample Number	EP Extracts (mg/l)			Waste† (mg/kg)		
		Cadmium	Chromium	Lead	Cadmium	Chromium	Lead
PA	1	0.026 ∓ 0.004	0.06 ∓ 0.006	3.1 ± 0.7	4.3 ± 0.6	81 ± 3	2140 ± 40
PA	2	0.014 ± 0.003	0.06 ± 0.001	0.6 ± 0.2	1.0 ± 0.0	72 ± 4	180 ± 50
PB	6	1.091 ± 0.003	0.07 ± 0.001	23.8 ± 0.8	79.9 ± 0.9	88 ± 1	20770 ± 370
PB	8	0.010 ± 0.006	BD	BD	BD	BD	BD
PC	12	0.015 ± 0.003	0.06 ± 0.008	0.2 ± 0.04	3.0 ± 0.6	193 ± 40	360 ± 60
PC	12 SP	0.007 ± 0.001	0.07 ± 0.002	0.2 ± 0.03	2.3 ± 0.3	227 ± 9	340 ± 80
PD	16	1.012 ± 0.001	0.07 ± 0.006	109 ± 7	35.0 ± 0.9	43 ± 0.9	18810 ± 2010
PD	16 SP	0.926 ± 0.016	0.06 ± 0.004	120 ± 1	31.3 ± 0.3	43 ± 0.9	17520 ± 100
PE	19	0.013 ± 0.002	0.07 ± 0.001	0.5 ± 0.1	3.3 ± 0.6	33 ± 6	9680 ± 250
PE	19 SP	0.012 ± 0.001	0.07 ± 0.004	0.4 ± 0.04	4.8 ± 2.6	36 ± 7	860 ± 430
PE	20	0.015 ± 0.009	0.07 ± 0.005	0.5 ± 0.3	4.3 ± 0.3	40 ± 1	980 ± 30
PF	22	0.006 ± 0.001	0.07 ± 0.003	0.2 ± 0.2	1.0 ± 0.0	26 ± 2	30 ± 0.7
PF	24	0.027 ± 0.002	0.07 ± 0.002	0.2 ± 0.02	6.8 ± 0.3	75 ± 2	290 ± 4
PG	28	0.081 ± 0.007	0.07 ± 0.003	10.2 ± 2.2	20.0 ± 2.9	78 ± 2	13030 ± 560
PH	34	1.683 ± 0.028	0.07 ± 0.005	10.4 ± 1.5	79.4 ± 0.9	1186 ± 8	10260 ± 20
PI	36	0.021 ± 0.000	0.07 ± 0.003	0.5 ± 0.05	3.2 ± 0.3	133 ± 8	950 ± 50
MJ	40	0.022 ± 0.002	0.10 ± 0.006	0.8 ± 0.1	4.3 ± 0.2	159 ± 13	680 ± 30
MK	42	0.557 ± 0.005	0.05 ± 0.003	0.8 ± 0.04	42.2 ± 0.6	165 ± 4	2650 ± 130
MKK	44	1.319 ± 0.102	0.10 ± 0.006	1.7 ± 0.4	134.1 ± 1.9	1548 ± 24	6210 ± 170
MKK	46	0.023 ± 0.012	0.07 ± 0.002	BD	3.6 ± 0.5	426 ± 57	100 ± 40
MKK	46 SP	0.024 ± 0.002	0.09 ± 0.01	0.2 ± 0.03	3.7 ± 0.1	392 ± 42	110 ± 20
ML	50‡	0.215	0.05	0.2	—‡	—‡	—‡
ML	51‡	0.011	0.07	0.4	—‡	—‡	—‡
MM	52	2.013 ± 0.248	0.11 ± 0.02	25.5 ± 5.7	1063.7 ± 6.4	148 ± 11	29630 ± 1170
MN	54	0.293 ± 0.053	0.06 ± 0.004	20.4 ± 3.8	17.1 ± 0.6	71 ± 1	2630 ± 20
MN	54 SP	0.243 ± 0.015	0.07 ± 0.02	9.4 ± 0.4	15.5 ± 0.9	74 ± 7	2370 ± 90
MNN	56	0.015 ± 0.006	0.06 ± 0.008	0.6 ± 0.09	2.1 ± 0.0	108 ± 6	370 ± 30
MNN	56 SP	0.015 ± 0.001	0.14 ± 0.13	0.6 ± 0.1	8.5 ± 0.1	322 ± 3	790 ± 30
MO	58	0.019 ± 0.004	0.06 ± 0.002	0.2 ± 0.03	2.3 ± 0.2	76 ± 2	250 ± 30
MP	60	0.062 ± 0.020	0.11 ± 0.009	2.3 ± 0.3	7.5 ± 0.0	301 ± 36	1950 ± 140
MQ	64	0.007 ± 0.001	0.06 ± 0.001	BD	2.9 ± 0.2	105 ± 2	90 ± 4
MR	66	2.279 ± 0.111	0.80 ± 0.06	BD	178.9 ± 8.3	2786 ± 231	390 ± 3
MR	66 SP	2.220 ± 0.085	0.86 ± 0.002	BD	173.7 ± 11.5	2671 ± 72	380 ± 20
MR	68	0.046 ± 0.002	0.29 ± 0.007	BD	8.1 ± 0.2	2210 ± 327	440 ± 20
MR	68 SP	0.062 ± 0.030	0.33 ± 0.005	BD	8.2 ± 0.2	2178 ± 47	450 ± 3
MS	70	0.598 ± 0.057	0.09 ± 0.008	12.6 ± 1.4	116.4 ± 7.1	131 ± 2	3540 ± 330
MT	74	0.010 ± 0.001	0.06 ± 0.004	0.4 ± 0.02	7.5 ± 1.1	148 ± 9	1920 ± 50
MU	78	0.0034 ± 0.0006	0.05 ± 0.003	BD	3.0 ± 0.0	122 ± 10	440 ± 50

** Average and standard deviation values are shown for triplicate portions prepared and measured at EPA-Las Vegas.*
† Amounts of metals released from the wastes by the digestion procedure employed.
‡ No digestion was performed since waste contained <0.5% filtrable solids.
BD = mg/l values for extracts below 0.004 for Cd, 0.03 for Cr and 0.05 for Pb; 100 x these values for mg/kg in wastes.
SP = Blind splits.

and milling) could not be used since breaking up the particles would most likely change the leachability characteristics of the material.

To verify our analytical results, aliquots of digested extracts that exceeded the critical concentrations for cadmium, lead, or both, were sent to LFE and to the University of Wisconsin for analysis. The results from the three laboratories were in excellent agreement.

An attempt was made to correlate high extract values for cadmium and/or lead with the type of furnace, scrubber and charge (as reported by the foundries in the questionnaires). All extracts from the three wastes produced by the electric arc process exceeded the limit for cadmium and one of them also for lead, although the composition of the charges used by the three foundries varied widely. Only three of 15 wastes from the Venturi-type scrubbers exceeded the limit for lead (and in one case for cadmium) whereas six out of eight wastes collected with the baghouse system exceeded the limit for one or both of these elements. The extract from the waste of a Michigan foundry, where lead-weighted wheels were noted among the scrap, exceeded the limit for lead by 50 percent. However, no correlation could be found between the charges used (as reported by the foundries) and the levels of cadmium and lead in the extracts.

Table 2. *Percentage of Cadmium, Chromium and Lead Extracted from the Raw Wastes by the EP**

Foundry Code	Field Sample Number	Percentage Extracted		
		Cadmium	Chromium	Lead
PA	1	12 ± 2	2 ± 0.2	2.9 ± 0.6
PA	2	28 ± 6	2 ± 0.03	7 ± 2
PB	6	27.3 ± 0.08	2 ± 0.02	2.3 ± 0.08
PB	8	I	I	I
PC	12	10 ± 2	0.6 ± 0.08	1 ± 0.2
PC	12	6 ± 1	0.6 ± 0.02	1 ± 0.2
PD	16	57.8 ± 0.06	3 ± 0.3	11.6 ± 0.7
PD	16	59.2 ± 1	3 ± 0.2	13.7 ± 0.1
PE	19	7.9 ± 1.2	4 ± 0.06	0.1 ± 0.02
PE	19	5.0 ± 0.4	4 ± 0.2	0.9 ± 0.09
PE	20	7.0 ± 4.2	4 ± 0.2	1 ± 0.6
PF	22	10 ± 2	5 ± 0.2	10 ± 10
PF	24	7.9 ± 0.6	2 ± 0.05	1 ± 0.1
PG	28	8.1 ± 0.7	2 ± 0.08	1.56 ± 0.34
PH	34	42.4 ± 0.7	0.1 ± 0.008	2.03 ± 0.29
PI	36	13 ± 0	1 ± 0.04	1 ± 0.1
MJ	40	10 ± 0.9	1.2 ± 0.08	2 ± 0.3
MK	42	26.4 ± 0.2	0.6 ± 0.04	0.6 ± 0.03
MKK	44	19.67 ± 1.52	0.13 ± 0.008	0.55 ± 0.13
MKK	46	13 ± 7	0.3 ± 0.009	I
MKK	46	13 ± 1	0.4 ± 0.05	4 ± 0.5
ML	50	I	I	I
ML	51	I	I	I
MM	52	3.78 ± 0.47	1.5 ± 0.3	1.72 ± 0.38
MN	54	34.3 ± 6.2	2 ± 0.1	15.5 ± 2.9
MN	54	31.4 ± 1.9	2 ± 0.5	7.9 ± 0.3
MNN	56	14 ± 6	1 ± 0.1	3 ± 0.5
MNN	56	3.5 ± 0.2	0.87 ± 0.81	2 ± 0.2
MO	58	16 ± 4	2 ± 0.05	2 ± 0.2
MP	60	16 ± 5	0.73 ± 0.06	2.4 ± 0.3
MQ	64	5 ± 0.7	1 ± 0.02	I
MR	66	25.48 ± 1.24	0.57 ± 0.04	I
MR	66	25.56 ± 0.99	0.64 ± 0.002	I
MR	68	11 ± 0.5	0.26 ±0.01	I
MR	68	15 ± 7	0.30 ± 0.005	I
MS	70	10.3 ± 1.0	1 ± 0.1	7.12 ± 0.79
MT	74	2.7 ± 0.3	0.8 ± 0.05	0.4 ± 0.02
MU	78	23 ± 0.4	0.8 ± 0.05	I

*Based on AA Data from Table 1 after conversion of the EP values to mg/kg basis.
I indicates Insufficient data (concentrations below detection limits).

Table 3. Confirmatory Atomic Absorption Analyses of EP Extracts[1,2]

Foundry Code	Field Sample Number	Element	Unspiked Reading	Spike Level (mg/l)	Spiked Reading	Spike Recovery (%)	Undiluted Extract (mg/l)	Std. Dev.
PB	6	Cadmium	0.220	0.500	0.719	100	1.089	0.015
				0.750	0.970	100		
				1.000	1.225	100		
PB	6	Chromium	0.03	2.50	2.73	108	0.05	0.15
				4.00	4.39	109		
				5.00	5.54	110		
PB	6	Lead	9.7	5.0	15.0	105	47.3	0.9
				7.5	17.5	104		
				10.0	20.0	103		
PD	16	Cadmium	0.178	0.500	0.676	100	0.888	0.017
				0.750	0.921	99		
				1.000	1.177	100		
PD	16	Chromium	BD	2.50	2.66	106	BD	—
				4.00	4.20	105		
				5.00	5.30	106		
PD	16	Lead	17.7	5.0	22.7	101	89.3	0.7
				7.5	25.2	101		
				10.0	27.6	99		
PG	28	Cadmium	0.026	0.500	0.521	99	0.123	0.012
				0.750	0.771	99		
				1.000	1.024	100		
PG	28	Chromium	BD	2.50	2.67	107	BD	—
				4.00	4.25	106		
				5.00	5.37	107		
PG	28	Lead	2.3	5.0	7.5	103	11.0	0.3
				7.5	10.2	104		
				10.0	12.7	103		
PH	34	Cadmium	0.362	0.500	0.861	100	1.802	0.031
				0.750	1.106	99		
				1.000	1.365	100		
PH	34	Chromium	0.04	2.50	2.68	106	0.12	0.13
				4.00	4.28	106		
				5.00	5.40	107		
PH	34	Lead	3.8	5.0	8.9	103	18.1	0.4
				7.5	11.5	103		
				10.0	14.2	104		
MKK	44	Cadmium	0.290	0.500	0.781	98	1.432	0.036
				0.750	1.035	100		
				1.000	1.291	100		
MKK	44	Chromium	0.04	2.50	2.65	104	0.10	0.21
				4.00	4.21	104		
				5.00	5.36	106		
MKK	44	Lead	BD	5.0	5.4	108	BD	—
				7.5	8.1	108		
				10.0	10.6	106		
MM	52	Cadmium	0.848	0.500	1.344	99	4.184	0.051
				0.750	1.601	100		
				1.000	1.858	101		

Table 3. (Continued)[1,2]

Foundry Code	Field Sample Number	Element	Unspiked Reading	Spike Level (mg/l)	Spiked Reading	Spike Recovery (%)	Undiluted Extract (mg/l)	Std. Dev.
MM	52	Chromium	BD	2.50	2.64	106	BD	—
				4.00	4.22	106		
				5.00	5.38	108		
MM	52	Lead	7.8	5.0	12.7	100	38.3	0.9
				7.5	15.4	101		
				10.0	17.9	102		
MN	54	Cadmium	0.073	0.500	0.572	100	0.358	0.023
				0.750	0.817	99		
				1.000	1.076	100		
MN	54	Chromium	BD	2.50	2.60	104	BD	—
				4.00	4.20	105		
				5.00	5.26	105		
MN	54	Lead	2.81	5.0	8.2	107	13.8	0.69
				7.5	10.6	103		
				10.0	13.2	103		
MR	66	Cadmium	0.548	0.500	1.045	99	2.709	0.038
				0.750	1.297	100		
				1.000	1.556	101		
MR	66	Chromium	0.22	2.50	2.77	102	0.99	0.13
				4.00	4.32	103		
				5.00	5.40	104		
MR	66	Lead	BD	5.0	5.0	100	BD	—
				7.5	7.7	103		
				10.0	10.4	104		
MS	70	Cadmium	0.079	0.500	0.568	98	0.379	0.029
				0.750	0.820	99		
				1.000	1.076	100		
MS	70	Chromium	BD	2.50	2.69	108	BD	—
				4.00	4.33	108		
				5.00	5.45	109		
MS	70	Lead	1.5	5.0	6.8	106	7.5	0.5
				7.5	9.3	104		
				10.0	11.8	103		

[1] The deuterium background corrector was not used for the chromium analyses because of inherent corrector limitations and because the EP extract chromium concentrations are below the hazardous waste criteria even without background correction. Readings were made on extracts diluted 5-fold per SW-846.

[2] BD indicates values below the detection limits of 0.005 mg/l for Cd, 0.025 mg/l for Cr and 0.47 mg/l for Pb. Lower detection limits for Pb are obtained when background corrector is not used.

• U.S. GOVERNMENT PRINTING OFFICE: 1981 - 757-012/7100

*The EPA authors **W. F. Beckert** (also the EPA Project Officer, see below), **T. A. Hinners**, **L. R. Williams**, and **E. P. Meier** are with the Environmental Monitoring Systems Laboratory, Las Vegas, NV 89114; **T. E. Gran** is with Northrop Services, Inc., Las Vegas, NV.*

The complete report, entitled "Sampling and Analysis of Wastes Generated by Gray Iron Foundries," (Order No. PB 81-206 575; Cost: $9.50, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Project Officer can be contacted at:

Environmental Monitoring Systems Laboratory
U.S. Environmental Protection Agency
P.O. Box 15027
Las Vegas, NV 89114

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